Backscattering of light by a finite two-dimensional plate in the region of excitonic absorption.

Kozlov G.G.

All-Russia research center "Vavilov State Optical Institute", St. Petersburg, Russia

e-mail: gkozlov@photonics.phys.spbu.ru

It is shown that the light scattered by a finite 2D crystal strip in the region of an exciton resonance should display strong backscattering. This phenomenon is related to the exciton reflection from the edge of the strip.

I. THE ESSENCE OF THE EFFECT

Recent achievements in fabrication of quasi-two-dimensional crystal structures - quantum wells, Langmuir-Blodgett films - give rise to growing interest to the spectroscopy of this objects. Usually optical excitations of these systems can be treated as excitons. This results in non-local character of optical susceptibility and strong effects of spatial dispersion. One of the effects of this kind is described below. Let us consider a finite 2D crystal strip (Fig.1) in XY plane which is infinite along Y-direction and occupies the interval $x \in [-l, l]$ along X-direction. A monochromatic wave (incident wave) falling on this structure from the upper half-space at some angle produces an exciton with the wave vector defined by the in-plane wave vector component of the incident wave. In the case under consideration (Fig.1) this exciton will propagate in the left direction. The polarization related to this exciton produces the scattered field giving rise to conventional reflected and transmitted waves. But due to the finiteness of the strip in the X-direction, the exciton reflected from the left edge of the strip appears. This exciton propagates in the right-hand direction, and the polarization related to this exciton produces a scattered wave counter-propagating with respect to the incident wave in the upper half-space and a symmetrical refracted wave in the lower half-space. So, we see that the light scattering on a finite crystal strip in the spectral region of exciton resonance is accompanied by a non-trivial backscattering in the upper half-space and by a symmetrical refraction in the lower half-space. This is the essence of the effect suggested. In the extended version of this letter we study a simple model of 2D exciton which allows us to calculate the excitonic Green's function and non-local susceptibility of a 2D finite crystal strip. Given the non-local susceptibility, we can calculate the scattered field for the case of the finite strip under consideration. The result of this calculation is presented on Fig.2.

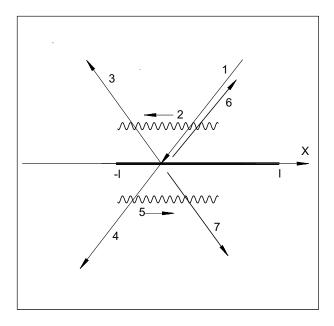


FIG. 1. Scattering of the plane wave by the two-dimensional crystal strip with exciton. 1. – incident plane wave, 2 – exciton produced by the incident wave running from the left to the right and the corresponding polarization. 3,4 – the conventional reflected and transmitted waves, 5 – the wave of polarization related to the exciton reflected from the left edge of the strip. 6,7 – scattered waves produced by the reflected exciton.

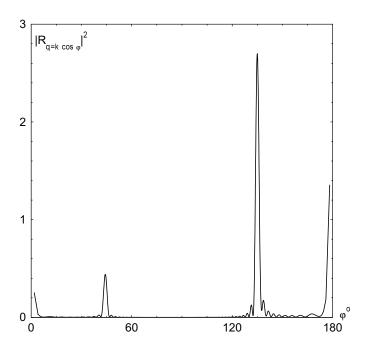


FIG. 2. Angular dependence of the scattering for the case of 2D crystal strip in the spectral region of the exciton resonance. The calculation is performed for the incident wave falling at 45° with respect to the plane of 2D crystal. It is seen that the conventional reflection (maximum at 135°) is accompanied by the backscattering peaked at 45° .